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Extrusion of cereals with admixture of soya bean grains from traditional crops

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Abstract

The paper presents characteristics of mixtures of soya bean extrusion process with wheat and corn and soya beans' meals with these cereals. On the Polish market, soybeans come mostly from traditional crops, for this reason its cultivation is much more expensive than soybeans derived from GM crops. Refuse soybean contains a large amount of fat that can be used as an additive enriching animal feed fat. It is however essential first soybeans processing. The extrusion process is one of the processing method refused soybean or whole soybeans as a component in extruded blends. The study used with isolated hulled and unhulled soybeans. From the analysis of the results obtained for the extrudates of mixtures with wheat and corn with addition of soya bean grains, it can be concluded that both the cutting strength and the hardness of the extrudates was higher in the case of corn compound. The greatest ratio of expansion was achieved for the extrudates of wheat and unhulled soya bean compound. The highest hardness was obtained by subjecting to extrusion a mixture of unhulled soya bean meal with corn, while introducing meal of hulled soya bean resulted in extrudates with about 70% lower hardness.

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*Keywords:*soybean; extrusion process; traditional crops.

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1. Introduction

Soya bean is a leguminous plant, which is classified among oilseeds due to the fat content that is higher than 15%. In addition to large amount of fat, it also has a high protein content, and hence soya bean products can serve as complete food. Fats contained in the grains are carriers of large amounts of polyunsaturated fatty acids in proper ratio to the monounsaturated ones. Essential unsaturated fatty acids, which include oleic acids, linoleic acids and α-linolenic acids are important compounds. These are the acids, which cannot be synthesized by body. Soya bean grains contain a lot of vitamins and minerals such as zinc, phosphorus, potassium, calcium, iron, B vitamins and vitamins A, C, E (Sikorski, 2007).

The development of biotechnology and genetics allows the modification of organisms in various ways, for example improving their resistance or altering components of their chemical composition. The first species of transgenic soya bean were obtained in 1988. An organism resistant to herbicide was the progenitor, thanks to which the technology of manipulation of the plant's genetics was developed. Subsequent varieties are characterized by pest resistance. There is also research carried out on alternation of nutrients in order to obtain better amino acid, carbohydrate, or fat profile. Thanks to the aforementioned modifications soya bean production has become cheaper, thus increasing the growth of the transgenic soya bean cultivation, which today can make up to 80% of the total world production (Borek, Galor, 2012).

Due to high fat content soya bean is used primarily in oil industry. In terms of usability for consumption soya bean meal is the most important by-product of oil extraction. It is rich in protein and amino acids, which play an important role in feeding livestock. On Polish market, soya bean meals come from conventional farms, hence production cost is higher than in the case of GM soya bean, the production of which is cheaper. Polish growers face strong competition from foreign producers of GM soya bean (Angulo et al. 1995, Jarczyk 2001, Świątkiewicz et al. 2013).

Nomenclature

No 1	Wheat grain + hulled soybeans
No 2	Wheat grain + soybeans
No 3	Malt residues after oil extraction from soybeans + corn
No 4	Malt residues after oil extraction from hulled soybeans + corn
No 5	Hulled soybeans + corn
No 6	Soybean+ corn

2. Aim of the study and methodology

The aim of the study was to characterize the extrusion process of mixtures of soya bean with wheat and corn and soya beans' meals with these cereals. Scheme of the research is shown in Figure 1. Since harvested soya bean is contaminated, during the cleaning step mineral impurities (sand, gravel, stones) and other biological contaminants such as grass and bits of other plants were separated. For the purpose of this study hulled soya bean grains and unhulled soya bean grits were used. After preparing samples with a total mass of 5 kg (and equal shares of 50%) the mixing process was carried out.

Obtained extrudates were tested for cutting and squeezing. Additionally, also the kinetic strength was determined using a Pfost method in accordance with PN-R-64834: 1998 norm.

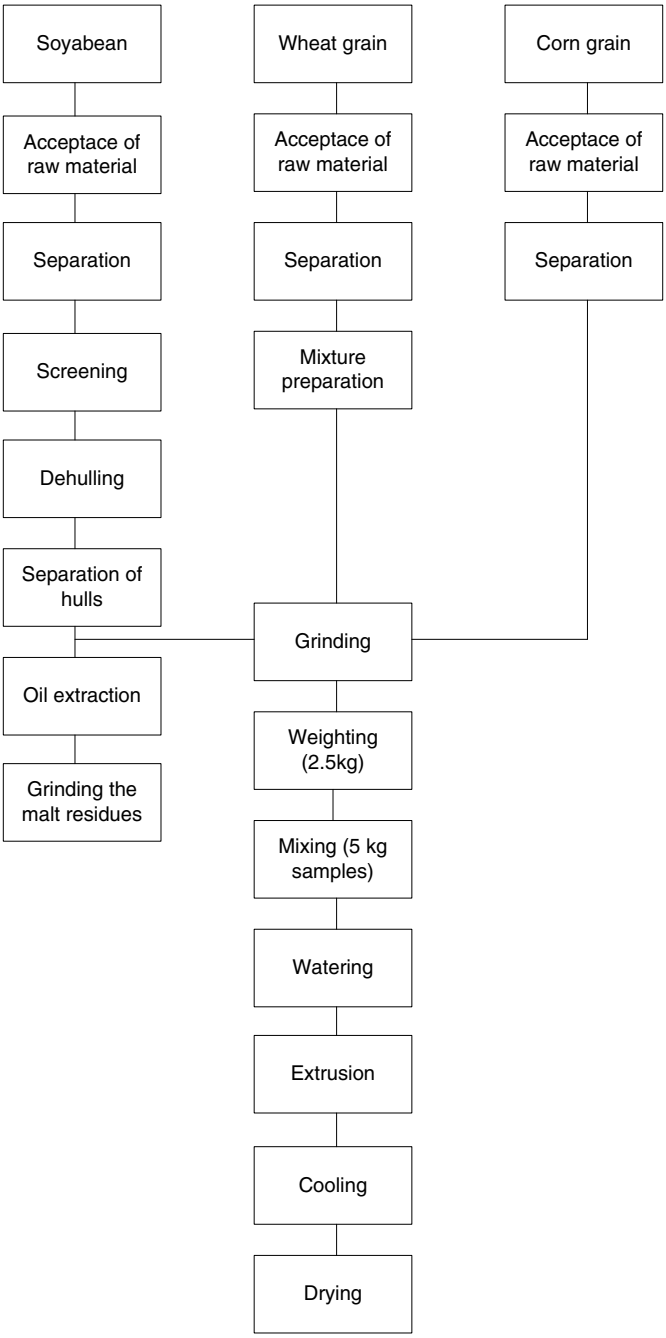

Fig. 1 Scheme of the study.

3. Results

The extrusion process characteristics are based on the measurements of the basic parameters of extrusion during its optimal operation. The results presented here are the outcomes of a series of preliminary tests with various

parameters. Similar parameters was tested during extrusion of pasta and wheat flour by other authors (Abecassis et al. 1994, Andersson, Hedlung 1990, Arhaliass et al. 2009, Chinnaswamy , Hanna 1988).

Table 1 Extrusion process parameters.

Sample	Temperature [°C]			Rotations	Comments
	Head	Second section	Extrudates		
Nr 1	150	185	80	100	No comments
Nr 2	120	150	74	60	No comments
Nr 3	110	145	84	100	No comments
Nr 4	150	195	90	70,80,100	Increased screw rotation
Nr 5	139	179	100	60	Too dry
Nr 6	150	180	72	60	Too dry

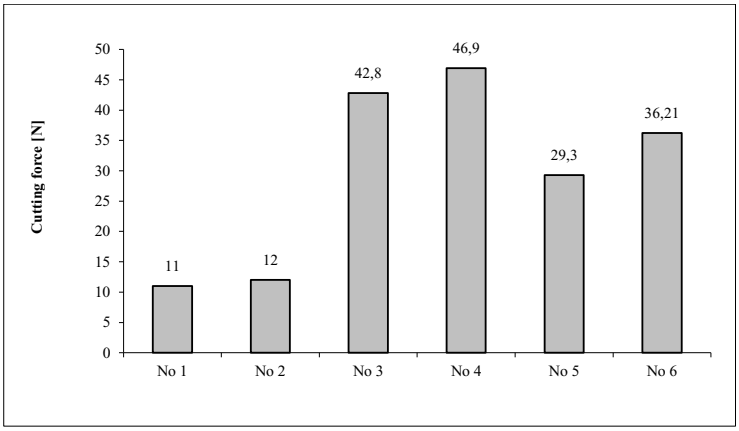

Fig. 2 Cutting force of extrudates.

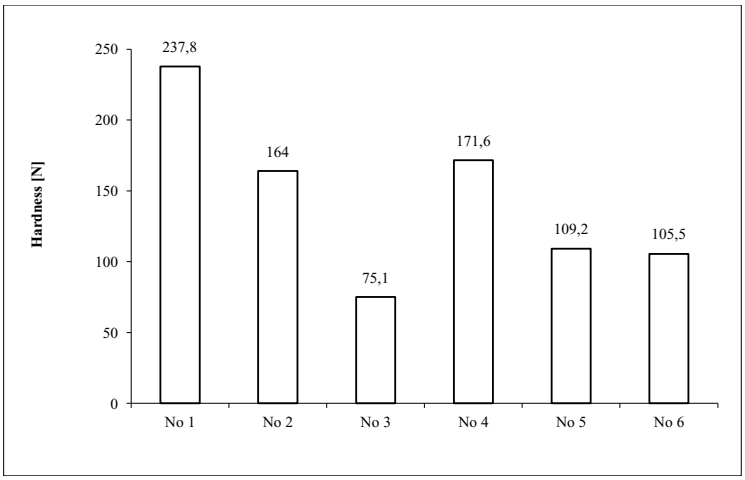

Fig. 3 Hardness of extrudates.

The resulting extrudates were characterized by final moisture content below 8%. The highest hardness was obtained by subjecting to extrusion a mixture of unhulled soya bean meal with corn, while introducing meal of

hulled soya bean resulted in extrudates with about 70% lower hardness. A similar correlation was obtained when measuring the cutting strength in relation to the respective meal compounds. The value of the cutting strength decreased by circa 50%.

From the analysis of the results obtained for the extrudates of mixtures with wheat and corn with addition of soya bean grains, it can be concluded that both the cutting strength and the hardness of the extrudates was higher in the case of corn compound. The greatest ratio of expansion was achieved for the extrudates of wheat and unhulled soya bean compound. The extrudates with admixture of wheat were characterized by the lowest kinetic strength of 50.4% for hulled soya bean and 45% for unhulled soya bean. At the same time, the extrudates with corn admixture had kinetic strength of 82%, regardless of whether hulled or unhulled soya bean has been added.

4. Conclusions

The research on soya bean extrusion process with added wheat or corn showed its significant impact on the extruded products. Extrusion process parameters varied depending on the type of the mixture, which is the outcome of the chemical composition of the input materials. Both the compression force and cutting strength of the extrudates depend on the composition of the mixture. Addition of corn caused increased resistance to compression and raised the cutting strength. The wheat-soya bean mixture had a high expansion ratio, but at the same time low kinetic strength, which may lead to fast crumbling of the product.

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